

Amendments to the Claims:

1. (currently amended) A geodesic structure comprising a plurality of hub elements, each hub element having a vertex at a first end and a hub base at a second end that is opposite said first end, an angular deficit α , wherein said hub elements are randomly arranged adjacent to one another so as to form said geodesic structure, a structure triangulated by a network of virtual struts, any one virtual strut of said network of virtual struts having a strut length and extending as a straight line between vertexes of any two adjacent hub elements.

2. (currently amended) The geodesic structure of Claim 1 having an angle of structure, wherein said hub element is a right cylindrical cone, and wherein, in an orthogonal elevational view of said hub element, said vertex connects a first hub side and a second hub side, wherein having an external angle θ that is formed between said second hub side and a first imaginary straight line extending straight from a surface of said first hub side cone beyond said vertex, and wherein having an internal angle β that is formed between a deficit line and a second imaginary line that extends vertically from said vertex toward said base and either one of said first hub side or said second hub side;

wherein said angle of structure is equal to an average value of said external angle θ of all said hub elements.

3. (canceled)

4. (canceled)

5. (canceled)

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6. (currently amended) The geodesic structure according to ~~Claim 4~~, wherein 2, wherein said plurality of hub elements includes more than one group of hub elements and said hub elements within each group are identical in size, and wherein said angle of structure is equal to an average value of said external angle θ of all of said hub elements in said geodesic structure.

7. (currently amended) The geodesic structure according to ~~Claim 4~~ Claim 6, wherein said plurality includes two groups of hub elements and ~~said hub elements~~, a first group having a first deficit angle α and a second group having a second deficit angle α that is different magnitude from said first deficit angle, and wherein said hub elements of said two groups are arranged in an alternating pattern.

8. (currently amended) The geodesic structure according to ~~Claim 1~~ further comprising a virtual strut having a strut length, said virtual strut extending as a straight line between any two adjacent vertexes of said hub elements, wherein said virtual strut is formed along a single-plane curvature that extends between said any two adjacent hub elements.

9. (unchanged) The geodesic structure according to ~~Claim 1~~, wherein said structure is a semi-spherical dome.

10. (unchanged) The geodesic structure according to ~~Claim 1~~, wherein said structure is a sphere.

11. (canceled)

12. (canceled)

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13. (canceled)

14. (canceled)

15. (currently amended) The geodesic structure according to ~~Claim 14~~, wherein said ~~element 1~~, wherein said hub element is fabricated of sheet material from the group consisting of metals, paper fiber products, wood fiber products, plastics, woven materials, pressed materials, and coated materials.

16. (currently amended) The geodesic structure according to ~~Claim 15~~ Claim 1, wherein said hub elements are arranged in an overlapping fashion so as to provide a closed surface.

17. (canceled)

18. (canceled)

19. (canceled)

20. (canceled)

21. (canceled)

22. (canceled)

23. (canceled)

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24. (new) The geodesic structure according to claim 1, wherein said strut length of said virtual struts is a variable strut length, wherein said strut length of a first strut between a first hub element and a second hub element is a first length and said strut length of a second strut between said first hub element and a third hub element is a second length that is different from said first length, and wherein said structure is self-adjusting by means of said variable strut length.

25. (new) The geodesic structure according to claim 2, wherein said hub element is a truncated right cylindrical cone.

26. (new) The geodesic structure according to claim 25, wherein said hub elements are arranged with said vertex pointing inward toward a center of said geodesic structure.

27. (new) The geodesic structure according to claim 25 further comprising a skin, wherein said hub element has an external side that faces away from said geodesic structure, and wherein said skin is arranged across said external side so as to form a continuous cover over said plurality of hub elements.

28. (new) A method of constructing said geodesic structure of claim 1, said method comprising the steps of:

- a) determining a desired radius (R) of said geodesic structure;
- b) determining a necessary number of said plurality of hub elements;
- c) arranging said hub elements in a random manner adjacent one another and fixing said hub elements in place; and

d) creating an opening in said geodesic structure for purposes of ingress and egress.

29. (new) The method of claim 28, wherein said step of determining a necessary number of said plurality of hub elements includes the steps of:

a) selecting a desired dome angle θ of said geodesic structure;

b) calculating an internal angle β ;

c) calculating said angular deficit α of said hub element by calculating $(360 \text{ degrees}) \times (1 - \sin \beta)$; and

d) calculating the number of said hub elements by calculating $(360 \text{ degrees})/\alpha$.

30. (new) The method of claim 29, further comprising the steps of

e) determining a strut length (SL) of said hub element, wherein $SL = (\sin \theta) (R)$;

f) determining a minimum hub length (L_{min}) of said hub element, wherein $(L_{min}) = SL/2$; and

g) calculating an actual hub length (L_{actual}) of said hub element.

31. (new) The method of claim 30, wherein said step of determining a minimum length includes calculating an amount of overlap between each said adjacent hub element.

Amendments to the Specification:

Please replace paragraphs with the amended paragraphs below:

[0016] The structure according to the invention is self-adjusting because the hub elements are not necessarily precisely spaced from each other, but are, rather, assembled in an approximate fashion arranged according to some general principle with virtual struts automatically forming along the single-axis curvature that extends from vertex to vertex. The geodesic dome thus constructed will have an overall shape with a curvature that corresponds to an average curvature of all the hub elements, as will be discussed below. Furthermore, the geodesic dome according to the invention is self-triangulated. If lines are drawn from each vertex to adjacent vertexes, one can see that the entire structure is divided into triangles, albeit triangles of varying dimensions, including scalene triangles in which each leg of the triangle is a different length.

Following paragraph [0045] please enter the following paragraphs:

[0046] FIG. 14 is an orthogonal view of a partial cross-section of the dome 100 of FIG. 5

[0047] FIG. 15 shows a partial view of a geodesic structure according to the present invention, constructed of truncated conical hub elements.

[0048] FIG. 16 shows a partial view of a geodesic structure according to the present invention, constructed of ten-seg elements.

DETAILED DESCRIPTION OF THE INVENTION

[0049] [0049] FIG. 1 shows a dome (prior art) based on the icosahedron, which is

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V_a, V_b, and V_c, respectively, and an internal angle β , are shown arranged around a diameter of the dome 100. The overlap between adjacent hub elements 5 is the maximal overlap, whereby the outer perimeter of hub element 5_a, for example, approaches the vertexes of adjacent hub elements 5_b and 5_c.

~~[0048]~~ [0052] To calculate the number of hub elements 5 needed for a hemisphere, the solid angle of 360° is divided by the angular deficit α . Knowing that the dome angle θ is 10°, the internal angle β is then equal to $(180^\circ - \theta)/2$, which is 85°. The angular deficit α is equal to $360^\circ(1 - \sin \beta)$, which is 1.4°. The number of hub elements 5 required is then $360^\circ/1.4^\circ$, that is, 257 hub elements 5. To calculate the hub length L, shown in FIG. 5, we first calculate the strut length SL, that is, the distance between vertexes V of the hub elements 5. As can be seen in FIG. 7-14, the strut length SL is equal to $\sin \theta \times R_a$, which, in this particular embodiment, is $(0.174)(5 \text{ m}) = 0.87 \text{ m}$. The minimum hub length L_{min} is SL/2 and the maximum hub length L_{max} is slightly shorter than the strut length SL. With hub length L_{min} and hub elements 5 that are arranged so as to just tangentially contact adjacent elements 5, the geodesic dome 100 comprising the 257 hub elements 5 described above will have a dome angle θ of 10°, a radius R of 5 m, an angular deficit α of 1.4°, and strut length SL of 0.87 m. Any amount of overlap between adjacent hub elements 5 must be added to the minimum hub length to determine the actual hub length L.

~~[0049]~~ [0053] In this first embodiment, the hub elements 5 are overlapped and, depending on the amount of overlap, the diameter of the resulting dome will be greater or smaller, but the dome angle θ will be 10°. The hub elements 5 can be overlapped maximally such that the outer edge of one element approaches the vertex V of each element that is immediately adjacent to it, or can be overlapped by any lesser amount that is still adequate to provide a completely enclosed space within the dome 100.

~~[0050]~~ [0054] In the example described above, the dome angle θ , which

corresponds to the external angle θ , was known to be 10° . The external angle θ is the amount of deflection between one leg of the hub element 5 and an extended line from the other leg of the same hub element 5 at the vertex V. As can be seen in FIG. 6 14, $(2 \times \sin \beta) + \theta$ is equal to 180° . If the angular deficit α of the hub element 5 is known, the external angle θ of the hub element 5 and the angle of structure θ of the structure can be calculated because, based on simple trigonometric equations, it is known that $\sin \beta$ equals $(1 - \alpha/180^\circ)$. So, for example, if the angular deficit α is approximately 1.4° , the dome angle θ of the dome 100 is approximately 10° .

~~100541~~ 100551 Since θ is a function of the angular deficit α of the hub element 5, it is possible to first define the dimension of the angular deficit α and then derive the other variables. If the Preferred Embodiment of the geodesic dome 100 is to be constructed of hub elements 5 that are provided as flat, circular sheets, it is a relatively simple matter to calculate the amount of material that must be removed from the circular sheets to produce suitable hub elements 5. If the desired dome angle θ , the desired radius, and the number of available sheets are known, the angular deficit α to construct a dome with the desired dimensions can be calculated. So, for example, if the desired dome angle θ is 8.5° , the angular deficit $\alpha = 360(1 - \sin \beta)$. The internal angle $\beta = (180^\circ - 8.5)/2 = 85.75^\circ$. Therefore, $\alpha = 0.99^\circ$. The number of hub elements 5 and the strut length SL are calculated as in the previous example.

~~100551~~ 100561 The number of hub elements 5 required to construct a particular dome depends on the strut length SL, the fraction of a sphere that the dome is to encompass, and the desired radius. It is, of course, possible to have a given number of hub elements 5 with a given angular deficit α and a given dimension for the overlap, and from these, determine the size of dome that can be constructed. The purpose of this illustration is not to limit the scope of the invention in any way, but rather, to show that a geodesic dome according to the present invention can be constructed to approximate dimensions, using only very basic mathematical skills and a basic

calculator that has trigonometric functions. The construction according to the present invention is referred to as a "self-adjusting" structure, meaning that the individual hub elements 5 can be approximately arranged in an overlapping manner and can be adjusted with more or less overlap to compensate for partial elements that would be required mathematically to make a sphere. For example, if the angular deficit α is 7° , the number of hub elements 5 required to construct a dome according to the method of the present invention is 51.4. The dome can be constructed with 51 or with 52 hub elements 5, some of which are adjusted slightly to overlap more or less to accommodate for the missing or added partial element.

~~[0053]~~ [0057] FIGS. 6, 7, 8, and 9 illustrate other types of hub elements that can be used to construct further embodiments of a geodesic structure according to the present invention. FIG. 6 shows a tapered truncated cone 11 for constructing a first alternative embodiment, FIG. 7 a tapered triangle 12 for constructing a second alternative embodiment, and FIGS. 8 and 9 show strutted frame elements 13 and 14, respectively, for constructing third and fourth alternative embodiments, respectively, of the geodesic structure according to the present invention. FIG. 10 shows a partial view of the second alternative embodiment of a dome 200 constructed of the tapered triangular elements 12 and a skin 17. Each triangular element 12 has a wide end 12A and a narrow end 12B. The elements 12 are arranged such that each element 12 touching adjacent elements 12, with the narrow end 12B facing in toward the center of the dome 200 forming the concave inner surface and the wide end 12A forming the outer convex surface. The first alternative embodiment according to the present invention uses the tapered truncated cones 11, is constructed similarly to the dome 200, and is also covered with a skin, as shown in FIG. 15.

~~[0054]~~ [0058] FIG. 11 shows a partial surface of the third alternative embodiment according to the present invention of a dome being constructed with the strutted frame elements 13. The elements 13 are hexagonal in shape and comprise three struts 1

the basis for almost all geodesic structures or domes that are constructed. A polygonal single-frequency icosahedron and a corresponding spherical icosahedron are shown in FIGS. 2 and 3, respectively.

[0046] [0050] FIG. 4 shows a first embodiment of a dome 100 according to the present invention and FIG. 5 shows a hub element 5. The dome 100 comprises a plurality of the hub elements 5, arranged so as to overlap that each individual hub element 5 overlaps with adjacent hub elements 5. As can be seen in FIG. 5, a section of material 9 is removed from a planar disc 8 between an imaginary vertical line l_2 that extends from the center of the planar disc 8 to a hub base 7 and a deficit line 6 to create an angular deficit α in the hub element 5. The edges that form the angular deficit α are then brought together and fastened, so as to form the hub element 5. The center of the planar disc 8 now forms a vertex V. Referring to FIG. 4, virtual struts 3 are indicated by dotted lines that extend between the vertices V. In this first embodiment, the hub element 5 is made from a plastic-coated disc of a paper-honeycomb-sandwich-construction. Many other stiffly flexible materials are suitable for the hub elements 5, such as, but not limited to, sheet metal, oriented-strand board, sheet plastic, paperboard, corrugated cardboard, wood, fiberglass, carbon fiber, leather, woven fiber, including plant fiber, etc., or suitable combinations of material.

[0047] [0051] Also shown in FIGS. 5 and 14 is an angle of structure θ , also referred to as an external angle θ and, when referring to this first embodiment, a dome angle θ . As shown, the angle of structure θ is formed by an imaginary straight line l_1 that extends from the plane of a first side of the hub element 5 beyond the vertex V and the plane of a second side of the hub element 5. For purposes of illustration, the radius R of the dome 100 is 5 m, the dome angle θ is 10° , and the number of hub elements 5 and the strut length SL are to be calculated. FIG. 14 shows an orthogonal view of a partial cross-section of the geodesic dome 100 constructed according to the first embodiment of the invention. Several hub elements 5, 5a, and 5c, each with a vertex

that are crossed in the center so as to form the hexagonal shape. A tension element 15 forms the perimeter of the strutted frame element 13 and is fastened with sufficient tension to force the struts 13A into a slightly bowed or convex-concave configuration. In this third alternative embodiment, strut ends 13B protrude beyond the perimeter of the strutted frame element 13. Adaptable couplers 16 are used to couple two strut ends 13B of two adjacent strutted frame elements 13. A plurality of frame elements 13 can be connected to form a sphere having the dome angle θ corresponding to the dome angle α of the strutted frames 13. The dome constructed of such elements is then covered with a skin, similar to the dome 200 described above, as shown in FIG. 15.

~~FIG. 12~~ [0059] FIG. 12 illustrates a very simple type of adaptable coupler 16, which is a tube, open at both ends. The strut ends 13B of two different strutted frame elements 13 can be inserted into the coupler 16. The coupler 16 is long enough to slidably hold the strut ends 13B within the coupler 16, yet allow the strut ends 13B to slidably adjust the position of the strutted frame elements 13 in place within the structure under construction. Many types of adaptable couplers 16 are available and suitable for holding the strutted frame elements 13 in a proper relationship to the other strutted frame elements 13 in the structure. Suitable couplers include clamps or tubes with holes or slots through which set screws or locking pins are insertable to hold the strut ends 13 in position.

~~FIG. 13~~ [0060] FIG. 13 illustrates a fifth embodiment of the invention, a map 500 of the earth. For purposes of illustration only, Oslo, Norway is the major point of interest on the map 500 and is located somewhat near the center of the map 500. The intended application of the map is to illustrate travel routes from Oslo to other points in the world. Initially, orthogonal projections of places of major interest are projected onto a sphere, each place of major interest surrounded by vertexes 18. Attention is given not to place the vertexes 18 on areas of particular interest, but instead, to place them in

areas of lesser interest, with respect to the particular focus of the map 500. Connecting lines 19 are drawn on the sphere to connect the adjacent vertexes 18. The resulting pattern made by the connecting lines 19 shows that the map 500 is omni-triangulated and that the triangles vary in size and are in some instances scalene triangles. The map 500 is then cut along some of the connecting lines 19 to allow the map 500 to lie flat. The map 500 has very little distortion, as the entire map is constructed of cartographic images of limited sections of the earth taken as orthogonal views.

~~[0067]~~ [0061] The embodiments mentioned herein are merely illustrative of the present invention. It should be understood that variations in construction and assembly of the present invention may be contemplated in view of the following claims without straying from the intended scope and field of the invention herein disclosed.

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